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Impaired executive control of emotional information in social anhedonia

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ABSTRACT

We examined the executive control of emotional information and its relationship to social functioning in individuals at risk for schizophrenia, defined by high social anhedonia (SA). Using the same structure as the Attentional Network Test (ANT), we developed a measure of executive control of emotional information (ANT-Emotion) in which subjects identify the direction of an arrow flanked by irrelevant angry or neutral faces. Subjects completed the ANT, ANT-Emotion, and the Social Adjustment Scale, Self-Report (SAS-SR), a measure of social functioning. While there were no group differences in the alerting, orienting, and executive control networks assessed by the ANT, high SA individuals exhibited a specific impairment in the executive control of emotional information. High SA individuals also reported poorer social functioning. However, executive control of emotional information did not mediate the relationship between SA and social functioning. These findings indicate that, in high-risk populations, the impaired ability to inhibit emotional information allows negative affective stimuli to exert inappropriate influence on cognitive processes. These results are consistent with studies indicating similar findings in schizophrenia patients, suggesting that impaired inhibition of negative emotion may be part of the liability for the disorder.

1. Introduction

Social anhedonia (SA), a lack of pleasure from social interactions that is distinguishable from social anxiety (Brown et al., 2007), is thought to be a core feature of schizophrenia that contributes to the liability of developing the disorder, and a key factor underlying the social difficulties seen in the illness (Meehl, 1962). SA predicts social functioning in individuals with schizophrenia (Blanchard et al., 1998) and high-risk populations (Cohen et al., 2006), is associated with elevated symptoms (Horan et al., 2007), and predicts conversion to schizophrenia-spectrum disorders (Kwapil, 1998). Similar to schizophrenia patients, socially anhedonic individuals also exhibit deficits in attention (Gooding et al., 2006b) and emotion processing (Phillips and Seidman, 2008). In line with data demonstrating social cognitive processes act as mediators between cognitive impairments and functional outcome (Green et al., 2000) the present research examines attentional processes in relation to emotional information in individuals high in social anhedonia. We hypothesize that attentional deficits affect social functioning via a specific domain of social cognition, the executive control of socially relevant emotional information, and that this relationship is part of an underlying vulnerability observable in psychosis-prone populations.

1.1. Attention & the attention network test

Attentional deficits in schizophrenia and psychosis-prone populations are well documented (Heinrichs and Zakzanis, 1998; Nuechterlein et al., 1998) but the mechanisms by which attentional processes influence social functioning are unknown. To understand attentional mechanisms and how they contribute to social impairments in SA a measure that can dissociate between specific domains of attention is needed. A promising candidate is the Attention Network Test (ANT) (Fan et al., 2002), an experimental measure of three proposed attention networks: alerting, orienting and executive control (Posner and Petersen, 1990). The alerting network manages the ability to achieve and maintain an alert state, the orienting network manages the ability to select and focus on the to-be-attended stimulus, and the executive control network manages the ability to resolve conflict among responses and consequently the regulation of cognitions and emotions (Posner et al., 2002).

There is increasing evidence for a specific deficit in the executive control network, as measured by the ANT, in schizophrenia (Wang et al., 2005; Gooding et al., 2006a; Urbanek et al., 2009). However, it is unclear whether this deficit is a consequence of schizophrenia, or if it is part of the liability for the disorder. Although executive control has been examined using the ANT in positive schizotypy (Wan et al., 2006), and individuals high in physical anhedonia (Dubal et al., 2000), to our knowledge ANT performance has yet to be examined in SA. Moreover, little is known about the contribution of deficits in the executive control network to social impairments in SA as executive control mechanisms have not yet been directly tied to social cognition and functioning deficits. We sought to examine 1) whether

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executive control deficits are present in high SA individuals, and 2) the role of the executive control network in a specific social cognitive process, the executive control of emotional information.

1.2. Executive control of emotional information

Executive control of emotional information – operationalized here as the ability to control the extent that emotion influences cognition – is critical for successful decision making and social interactions; if an individual is unable to inhibit irrelevant emotional information in the social array this could adversely affect social interactions. In schizophrenia, neuroimaging studies show dysfunctional activity in the lateral prefrontal cortex (Barch, 2005), a region involved in the regulation of emotion on behavior (Ochsner and Gross, 2005). In behavioral studies, individuals with schizophrenia show increased latencies on the Stroop task for threat-related or paranoid words compared to depressed individuals and healthy controls (Bentall and Kaney, 1989), and are more influenced by negative affective primes when rating the trustworthiness of neutral faces (Hooker et al., 2011). Collectively, these findings are indicative of deficits in the executive control of emotional information in schizophrenia, and that these deficits directly affect social behavior, potentially contributing to social impairments. Thus, we were interested in investigating whether psychosis-prone individuals also exhibit impairments in the executive control of emotional information, and whether these impairments relate to social functioning.

High SA is associated with executive functioning impairments (Tallent and Gooding, 1999) and aberrant processing of affective information (Kerns and Berenbaum, 2000), indicating that dysregulation of inhibitory mechanisms, such as executive control, and emotion processing is present premorbidly. However, the interplay between affective information and executive control in SA has received limited attention in the literature. If high SA is related to difficulties in controlling the influence of emotional information on behavior, it may contribute to social deficits. Thus, we were interested in whether executive control of emotional information is impaired in socially anhedonic individuals, and whether this mediates the relationship between SA and social functioning.

1.3. The present research

The present research examined attentional processes, specifically the executive control of emotional information, and social functioning in high SA individuals and healthy controls. We developed a direct measure based on the ANT: the ANT-Emotion, a flanker task with orienting cues in which participants identify the direction of an arrow flanked by irrelevant neutral or angry faces. SA was assessed with the Revised Social Anhedonia Scale (Eckblad et al., 1982). We also administered the ANT as a measure of pure attentional processes, and the Social Adjustment Scale–Self Report (Weissman et al., 1978) as a measure of social functioning.

We directly tested the following predictions: 1) Compared to controls, high SA individuals will exhibit attentional deficits on both the ANT, specifically in executive control, and the ANT-Emotion, specifically in the executive control of emotional information. 2) High SA individuals will report poorer social functioning compared to controls. 3) Executive control of emotional information will mediate the relationship between SA and social functioning.

2. Methods

2.1. Participants

34 high SA and 29 control participants were recruited from the Greater Boston Area. Participants were recruited as part of a larger study ($N = 108$) investigating the relationship between psychosis-proneness, social cognition, and social functioning in which they were screened for SA with the Revised Social Anhedonia Scale (RSAS) (Eckblad et al., 1982), and also completed the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991). Candidate high SA participants were selected from the larger study sample using the cut-off of 1.96 standard deviations above the mean for their gender from normative data reported by Kwapil (1998): scores of 16 and above for females; 20 and above for males. In order to compare high SA individuals to individuals who are not at risk for schizophrenia, candidate control participants were individuals who scored below 1.96 standard deviations from the mean on the RSAS and within the 10% cutoffs of the SPQ from the normative data reported by Raine (1991) (SPQ scores less than 8 or greater than 42). Thus, control participants were individuals with no elevated risk for schizophrenia, scoring within the normal range of the SPQ and the RSAS. Exclusion criteria were: English as a second language, IQ below 70, history of head trauma, neurological illness, current or past axis I disorders, and active substance abuse within the past six months.

Demographic information and group differences are presented in Table 1. The study was approved by the ethical review board at Harvard University. After study procedures were explained, participants gave written informed consent.

2.2. Materials & assessments

2.2.1. Social anhedonia

The Revised Social Anhedonia Scale (RSAS) (Eckblad et al., 1982) is a 40 item true/false self-report scale comprising of questions measuring individuals' decreased pleasure from social interactions. Example items include: "I attach very little importance to having close friends" (keyed true) and "Just being with friends can make me feel really good" (keyed false).

2.2.2. Psychiatric illness

Axis I disorders were assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders (First et al., 2002); clinical interviews were conducted by trained master's level doctoral students and supervised by a licensed clinical psychologist (CH). Reliability assessments conducted by an independent clinician on a random sample of ten clinical interviews revealed a kappa of 0.67, indicating substantial diagnostic agreement (Landis and Koch, 1977).

2.2.3. Intelligence

Full scale IQ scores were estimated using the vocabulary and matrix reasoning subtests of the Weschler Abbreviated Intelligence Scale (WASI) (Wechsler, 1999).

2.2.4. Social functioning

Social functioning was assessed with the Social Adjustment Scale – Self Report (SAS-SR) (Weissman et al., 1978). The SAS-SR consists of 54 questions assessing six areas of functioning: work, social and leisure activities, relationships with extended family, role as marital partner, parental role, and role within the family unit. Each area is rated across four categories of assessment: performance at expected tasks, level of conflict with people, interpersonal relations, and feelings and satisfactions. Area scores are averaged together to create one composite score of social functioning.

2.3. Tasks and stimuli

2.3.1. The ANT

The ANT (Fan et al., 2002) assesses the efficiency of the orienting, alerting, and executive control attentional networks by measuring differences in reaction times to indicate the direction of a central arrow across cue and flanker conditions. Participants identify the direction (left, right) of a target arrow that appears above or below a central fixation cross. The arrow is preceded by an asterisk cue that either alerts or orients participants to the upcoming target. There are four cue types: no cue (neither alerting nor orienting), central cue (on the fixation cross; alerting), double cue (two asterisks presented simultaneously above and below fixation; alerting), or spatial cue (a single asterisk above or below fixation in the location of the upcoming target; orienting). Immediately after the asterisk cue, the target arrow appears and is flanked by one of three flanker types: congruent (arrows in the same direction as the target arrow), incongruent (arrows in the opposite direction as the target arrow) and neutral (horizontal lines). The alerting and orienting networks are assessed via the different cue conditions, the executive control network is assessed via the different flanker conditions. Measures of the efficiency of the three attentional networks are obtained via simple subtractions of reaction times between conditions: alerting scores are calculated by subtracting reaction times in the double cue condition from reaction times in the no cue condition; orienting scores are calculated by subtracting reaction times in the spatial cue condition from reaction times in the center cue condition; executive control scores are calculated by subtracting reaction times in the congruent flanker condition from reaction times in the incongruent flanker condition.

The task consists of 288 trials; 72 in each of the four cue conditions. Each trial is 4000 ms beginning with a fixation cross, followed by one of the four cue types presented for 100 ms, followed by an average interval of 400 ms after which one of the three target stimuli is presented for 1700 ms or until the subject responds (congruent, incongruent, neutral). The task was presented on an IBM ThinkPad laptop using e-prime professional version 2.0.

2.3.2. The ANT-Emotion

Using the same structure as the ANT, the ANT-Emotion is designed to assess the orienting and executive control attentional networks in relation to emotional information. Orienting to emotional information is assessed by using faces (neutral, angry) as spatial cues for the upcoming target. Executive control of emotional information is assessed by using faces (neutral, angry) as flankers of the central target arrow. Participants